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U.S. National security is based on a strategy of deterrence. Rather than attempting to match adversaries one-to-one in personnel and weapons systems, the U.S. strives to maintain a level of technological superiority sufficient to overcome numerical disadvantages. The strength of this deterrence is dependent on the ability of the U.S. to maintain technological superiority. Factors that degrade U.S. technological superiority ultimately compromise deterrence. One such factor is globalization of the economy which is accompanied by worldwide dissemination of technologies applicable to both commercial and military use (i.e., "dual-use"). Competition in semiconductors, computers, fiberoptics and the whole spectrum of microprocessor controlled products is global, with U.S. preeminence threatened by Japan. Globalization also creates a U.S. dependence on foreign manufactured electronic components critical to our defense systems. As the U.S. loses its competitive edge in high technology, the strength of U.S. deterrence declines at a proportionate rate. In this paper, the problem of a declining U.S. defense industrial and technology base is discussed

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The Decline of the U.S. Defense Industrial and Technology Base:

The Impact on National Security

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INTRODUCTION

U.S. national security is based on a strategy of deterrence. Rather than attempting to match adversaries one-to-one in personnel and weapons systems, the U.S. strives to maintain a level of technological superiority sufficient to overcome numerical disadvantages. The strength of this deterrence is dependent on the ability of the U.S. to maintain technological superiority. Factors that degrade U.S. technological superiority ultimately compromise deterrence. One such factor is globalization of the economy which is accompanied by worldwide dissemination of technologies applicable to both commercial and military use (i.e., "dual-use"). Competition in semiconductors, computers, fiberoptics and the whole spectrum of microprocessor controlled products is global, with U.S. preeminence threatened by Japan. Globalization also creates a U.S. dependence on foreign manufactured electronic components critical to our defense systems. As the U.S. loses a competitive edge in high technology, the strength of U.S. deterrence declines at a proportionate rate. In this paper, the problem of a declining U.S. defense industrial and technology base is discussed and contrasted with increasing technological competitiveness from Japan. First, sources of the U.S. decline in technological competitiveness are described. Second, Japan's strategy for world dominance of targeted technologies is discussed. Third, the emergence of Japan as a legitimate competitor in military technology is presented. Finally, recommendations for a course of action to bring the U.S. defense industrial and technological base back to a competitive edge are presented.

THE U.S. DEFENSE TECHNOLOGY BASE: MISSION AND DECLINE

The technology base encompasses basic research and development efforts funded under the budget categories of 6.1 (basic research), 6.2 (exploratory development) and 6.3A (advanced technology development - feasibility). These efforts provide three critical functions. First, new technology options are provided for the near-term (6.2 and 6.3A) and long-term (6.1 and 6.2). Second, the technology base (primarily 6.2 and 6.3A) supports later product development stages in systems engineering. Third, the 6.3A effort contributes to improved technology utilization and technology transfer. The need for short-term results and immediate 'relevancy' to direct military application are the governing criteria in planning and programming the defense technology base. Programs which are the most competitive for funding are the programs with clearly perceived near-term military relevancy. There is a 'quick fix' attitude which is pervasive in the technology base program focus. As a result, funding decrements often occur in the longer range but inherently higher leveraged research programs of relatively great potential importance. Consequently, the Department of Defense (DoD) 6.1 basic research program is not keeping pace with state-of-the-art defense technologies. An obviously short-sighted practice of shifting technology base funds to 'save' later stage development projects in financial difficulty is prevalent.

In constant 1988 dollars, the DoD FY 89 budget is in the fifth straight year of decline.[1] Moreover, the DoD research, development, testing and evaluation (RDT&E) funding profile over the years is deceptive. Although RDT&E maintained a constant share of the DoD budget throughout the military buildup

of the 1980's, rising from $16.6 billion to $43.7 billion, most of this growth occurred in the funding categories of advanced development (6.3B - based on system application) and engineering development (6.4).[2] Little growth, on the other hand, has occurred in the defense technology base which is vital to long-term strategic planning. In 1964 DoD funding for basic research and exploratory development peaked at $5.9 billion (in constant FY 89 dollars).[3] Today, basic research and exploratory development in DoD are funded around $3.4 billion.[3] This represents about 2.9 percent of annual DoD expenditures. The cumulative shortfall in the defense technology base from the funding peak in 1964 amounts to approximately $25 billion.[3] This represents a technical effort of approximately 150,000 man-years of research and development that would have been carried out had the funding level remained constant.[3] As a result, less money is available for basic research and in exploring new ideas for military systems. The implications of such a funding shortfall in the technology base is realized in the out years. The research, development and acquisition of military systems take approximately 15-20 years for basic research advances and 10 years for technology advances to be incorporated into deployed systems.[3] Therefore, the impact of diminished technology base funding today will be visible as shortfalls of technology in systems deployed in 10 years or more. With less money invested into the technology base for industry to develop new military products, foreign products become more competitive. On a global scale, the funding decline in the technology base compromises technological competitiveness of the U.S. defense industry.

THE DECLINE IN U.S. GLOBAL TECHNOLOGICAL COMPETITIVENESS

In general, the U.S. decline in technological competitiveness evolves from a philosophy of emphasizing short-term profits over long-term investment, allowing direct access to U.S. technologies, diminished production innovation, and increased foreign investment in research and development. The initial decline in U.S. technological competitiveness is largely due to shortsightedness and rigidity in U.S. government policies, industrial structure and corporate strategy. One critical problem is the inability of industry to link long-term planning with the ability of the defense technology base to support national security objectives. Hence, there is no direct tie between industrial policy and national security goals. American industry is focused on short-term profits rather than long-term productivity and growth. The defense industry is under investor pressure to provide short-term returns at least equal to those of low risk investments. The uncertainty about the U.S. defense budget and defense policies creates investor skepticism toward investment in defense stocks. In 1982 there were more than 188,000 companies under contract with the DoD to provide manufactured goods. However, by 1987 there were fewer than 40,000.[4] U.S. defense industries are viewed as long term investments with high risk and low capital returns. Therefore, U.S. industry is not likely to pursue long term and high risk investments in research, development, modernization and productivity for defense systems. As a result, American industry is decreasing corporate exposure to defense contracting or limiting capital expenditures in the defense sector.

Another source of decline in the U.S. defense industry is international competitive pressure. Other countries have become major investors in research and development. In fact, the trend indicates that the U.S. is contributing a declining percentage of the world's technology base because of accelerated global investment in science and advanced technologies. As a direct result, the probability of becoming 'blind-sided' by a foreign competitor's technological breakthrough increases. The U.S. government investment in civilian research and development for industrial growth is less than 1 percent, the lowest among the major industrialized countries. Japan, on the other hand, invests 6 percent of their government research and development funding for industrial growth.[5] This particular investment strategy impacts significantly on the ability of the U.S. to develop and produce dual use technologies.

Over the past 20 years, U.S. industry's substantial productivity advantage diminished considerably or disappeared altogether in a number of key defense sectors such as steel and semiconductors.[6] U.S. productivity in these industries grew an average of less than 1 percent per year over the last 10 years, compared with more than a 3 percent growth rate annually in the 1950s and 1960s. During this same period, productivity grew at four times that rate in Japan.[7] Moreover, the U.S. is not making the necessary investments in research and development necessary to maintain competitiveness in production and processing technologies. The irony is that the U.S. is still competitive in basic science and engineering. New scientific principles are rapidly acquired and incorporated into concepts that drive technological change.

However, in channeling basic technological advances into new products and processes the U.S. lags behind Japan, especially in electronics.

What further compromises technological competitiveness is that U.S. policies for trade and military research and development permit foreign countries direct access to U.S. technological resources. Of great importance to national security is import penetration into the defense industrial base. In total, import penetration grew between 1980 and 1986 in 104 out of 122 defense sectors examined.[4] This problem initially arose during U.S. dominance of global technology prior to 1975. During this period Japan restricted U.S. imports and direct investment while utilizing U.S. technology. More recently, U.S.-Japanese cooperation in high technology reflects not only a U.S. decline but a dependence on Japan. In both the high technology components of military systems and in global finance, Japan will clearly remain a top competitor.

THE JAPANESE MODEL OF TECHNOLOGICAL COMPETITIVENESS

There must be a critical link between long-term planning and the strength of an industrial and technology base to support national security objectives. Japan's government is intricately tied to the industrial and technology base. The Ministry of International Trade and Industry (MITI), of which there is no U.S. counterpart, is primarily engaged in long-term planning for the development of both civilian and defense sectors. This long-term planning effectively transfers technologies and products originally developed for the civilian sector to the defense community or from the defense community to the civilian sector. Hence, dual use technologies are readily exploited. The defense industrial and technology base is supported by the Japanese government

by direct subsidies and tax provisions resulting in low capital costs and government-sponsored research and development. When comparing research and development versus gross national product (GNP), Japanese costs of capital are one-fourth those of the U.S.[•] The Japanese Defense Agency or the MITI frequently directs or coordinates joint research, product development, testing, and allocation of market shares. In contrast to the U.S., Japanese companies engage in far less competition with each other for defense research and development funding. The diminished competition for defense business is enhanced by the unique joint commercial efforts in which various companies engage without the restraint of antitrust laws. Japanese defense technology is greatly enhanced by overall investment in research and development, despite the fact that a major part of it is allocated for non-military research. Although Japan conducts little direct defense research and development, Japan ranks third, behind the U.S. and USSR, in total investments in science and technology.[•] Japan's philosophy has emphasized applied research, development, and production (i.e., process) technology which is precisely applicable to the defense community. Although funding for basic research is not a priority, Japan targets a substantial percentage of research to product development. On the other hand, Japan, by recent national policy decision, is developing a strategy on basic research to sustain long-term economic growth and enhance their goal of global economic dominance. This strategy will complement their already formidable strength in applied technology.

Japan uses a targeting strategy which closes Japanese markets to foreign technologies while acquiring a larger share of the international market by

selling products at prices below production costs. Japan's targeting policy is built on four elements: (1) coordinated government actions; (2) channelling production resources in a specific direction; (3) targeting specific technologies; and (4) optimizing the competitive advantage for Japanese producers of a given technology. Japan's targeting strategy is shifting from steel, ships and automobiles to electronics and semiconductors. The implementation of Japan's targeting strategy is evident. Japanese high-technology industry systematically limits the U.S. industry from Japanese markets; imports and duplicates U.S. technologies; and then exports back into the U.S. market. Thus, Japan's strategy is to restrain foreign high technology competition, acquire targeted technologies from outside, promote rapid design cycles and short product life spans; and progress from low-cost mass market products to advanced and differentiated high-technology products. This strategy is especially suited to information processing hardware technologies, especially those related to electronic components and semi-conductors which have dual use application.

INDUSTRIAL INNOVATION IN JAPAN

Japan's technological strategy is to foresake heavy investment in the technology base and promote aggressive investment in production and process technology. This strategy relies on the ability to channel technology base activities acquired mostly from the U.S. into Japan's advanced engineering and development programs. Therefore, it should be of no surprise that Japanes industry tends to develop and commercially introduce new products and processes more quickly than do U.S. industries. This is particularly true for the

chemical, rubber, machinery, instruments, metals, and electronics industries, which make-up a significant portion of the defense industrial base. Moreover, on the average, Japanese industries also develop and commercially introduce new products and processes at a lower cost compared to U.S. industries. However, these advantages are confined to products and processes developed from external technologies, that is, technology developed outside the innovating organization. There appears to be no significant difference between the U.S. and Japan in cost and development time of innovations based on internal technology.[10] That should be expected since Japanese government and industry have not invested heavily in their own technology base but relied on the ability to transfer outside technology into process and production technology. U.S. firms require nearly twice the length of time and nearly twice the cost to carry out an innovation based on external technology compared to one based on internal technology.[10] On the other hand, Japanese firms require 25 percent less time, and half the cost to carry out an innovation based on external technology compared to one based on internal technology.[10] Many of the Japanese innovations based on external technology are new products that imitate U.S. designs. Without question, this investment strategy is leading Japan to a highly technologically competitive level on a global scale.

Japan is considered the world leader in electronics as a whole. Japan's electronics exports are nearly $65 billion and are eight times greater than their electronics imports.[11] On the other hand, the U.S. is a large net importer of electronics worldwide and a net importer from Japan of advanced electronic materials, computer-controlled systems, computers, robots,

semiconductors and telecommunications equipment. Japan's share of the world semiconductor market has nearly doubled, to 49 percent, while the U.S. share has declined from 55 percent to 39 percent.[11] Japanese industry has 90 percent of the world market for the newest generation of semiconductor memories - 1-megabit DRAMS (dynamic random access memory chips) that are critical to all military computer systems.[11] Moreover, Japan's share of world computer production has doubled to 20 percent over the last decade, and exports have risen by a factor of 15.[11] Japanese high-technology producers are establishing ties to U.S. technology sources such as universities, national laboratories, and start-up firms while continuing to discriminate against U.S. high-technology firms in Japan.

JAPAN'S DEVELOPING DEFENSE TECHNOLOGY BASE

The growth of Japan's defense industry is a striking parallel to their commercial electronics industry growth. The Japanese government has decided on an overall fiscal 1989 budget of $476 billion, 6.6 percent more than the previous year.[12] The new defense budget plan includes $30.86 billion for defense appropriations and $725 million for the Technical Research and Development Institute.[12] In contrast to the 5.9 percent increase in defense spending over fiscal 1988, other department budgets have remained at the same level as the previous year or reduced. With a continuous build-up in the defense budget, Japan is ranked as the world's sixth defense power. Japan's defense industry strategy centers on domestic protectionism, licensed technology, access to U.S. technology and defense facilities, and a systematic progression to advanced products. This is precisely the same way that Japan

developed their industrial base to become the most dominant competitor on an international scale.

Although Japan is not exporting weapons systems to date, there is a capability to export weapons. American policy actually facilitates Japanese production of U.S. weapons as a way of sustaining wartime supplies, while U.S. weapons export procedures are unwieldy. The result is a massive transfer of technology through licensing arrangements to Japanese firms which U.S. defense firms find highly profitable in the short-run. Over the long term, however, Japan will certainly be a competitor in weapons systems production. The Japanese defense industry currently possesses licensing or coproduction arrangements for the FSX series of combat aircraft, military helicopters, missile systems and many military electronics systems. Moreover, several Japanese electronics firms are supplying large dual-use subsystems, such as aircraft communication units, to U.S. defense contractors. The quality of Japanese defense technologies makes them highly competitive with U.S. systems to the extent that the DoD has considered several acquisition strategies including buying and renting Japanese weapons systems.

If these trends continue, many Japanese defense technologies will be clearly superior to their U.S. counterparts and the U.S. will grow increasingly dependent on Japan for military technology. Ultimately, the DoD may be forced to choose between technologically inferior U.S. military technology and superior Japanese weapons systems. The solution requires a coordinated response by both U.S. industry and the DoD to revitalize the technology base and enhance the productivity resulting from science and technology.

CONCLUSIONS

Continued deterioration of the defense technology base severely compromises the credibility of U.S. deterrence. Several steps are necessary to strengthen the technology base. First and foremost, defense technology base funding must be stabilized. Second, the technology base effort must be directed away from a "quick fix" short term focus and toward a "long range" purpose and mission. Execution of the technology base program should then be continually evaluated against specified long range goals and objectives. Within the DoD, responsibility for the technology base should be centralized, driven by a "corporate management" perspective, and closely tied to the industrial base. Similarly, a concentrated effort must be made to develop an "investment" strategy for the technology base to meet national security objectives. Funding the technology base and establishing a long range focus, however, will not alone enhance U.S. global technological competitiveness and stabilize national security. Technology base programs produce innovative ideas which significantly contribute to defense systems capabilities only if there is a concentrated effort to apply technology. The DoD and industry are seriously deficient relative to some of our international competitors in rapid incorporation of technology into systems and products, accounting in large part to the growing decline in U.S. technological competitiveness, especially in dual-use technologies. There must be a concentrated effort to rapidly apply technology to implemented systems. This should be accomplished in the early advanced development phase (6.3A) of the technology base. Applying technology to existing systems is easiest to accomplish, least expensive and of less risk.

Inserting radical new technologies into new military systems produces the greatest advantages in military capability, but with concomitant problems in user acceptance and maintainability. The more radically advanced weapons often involve greater risk, higher costs, and change in existing training and doctrine. Some of these impediments, however, can be overcome by using a technology base program, such as Advanced Technology Transition Demonstrations (ATTD), to rapidly transition technology into fielded systems.

Defense procurement should also shift toward commercial 'dual-use' components to increase productivity and stimulate the industrial base. Most critical defense technologies can be classified as 'dual-use' in that they are important for industrial competitiveness in global markets as well as to defense systems. Accelerating technological developments in commercial products also accelerates their availability for use in military systems. As the emphasis on the use of commercial components in military systems increases, the commercial value of dual-use technologies will also increase. The DoD must take the lead in three important roles in the exploitation of dual-use technologies. First, DoD must strengthen the defense scientific and engineering infrastructure to generate new technologies. DoD should implement policies and procedures to compensate and reward high quality scientific talent in military laboratories, stabilize the technical leadership of research laboratories and programs, and initiate incentives to attract or retain high quality technical personnel. Second, there must be an improved financial incentive for industry to invest in the defense industrial base. Independent Research and Development (IR&D) represents a contractor's cost not sponsored

by, or required in the performance of a research and development contract. IR&D is a critical ingredient of the scientific and engineering infrastructure and is resident in the industry that uses it. Therefore, IR&D is very effective in developing and applying technology into defense systems. The DoD should structure IR&D to reflect long-term assessment of defense technology requirements, independent of specific budget levels. IR&D will then encourage more long-term industry investment and thereby strengthen the industrial base. Third, the DoD must strengthen the industrial base for the accelerated throughput of advanced technology materials and components into defense systems. DoD should therefore establish an agency, similar to the Japanese Ministry of International Trade and Industry, which will engage in long-range planning for development of dual-use technologies. This planning should focus on two areas. First, technology transfer and product application between the civilian and defense sectors. Second, identifying areas which warrant allocation of research and development resources, developing incentives for industry, and acting as liason between private companies.

The U.S. defense industrial base should exercise caution in any expansion of multinational operations which require alliances with foreign competitors where our technological leadership may be compromised. An illustrative case is the U.S. - Japan Memorandum of Understanding on the co-development of the FSX fighter aircraft and the conclusion of an industrial accord between General Dynamics and Mitsubishi Heavy Industries defining work shares on the 1.2 billion dollar project.[13] The FSX is based on F-16 General Dynamics technology, but will incorporate components developed in Japan. Joint weapons

development projects such as the FSX assures Japan continued direct access to U.S. sensitive technologies. Transferring technology to Japan's developing defense industry will only lead to greater competition for the U.S. in future weapons systems. Currently, Japan does not permit the export of military equipment but is likely to do so if the market demand exists. Moreover, the type of dual-use technologies which are transferred in the FSX program will ultimately be incorporated into Japan's commercial aerospace industry. Japan could quickly gain a major share of the international aerospace industry, primarily at the expense of the market-leading U.S. In the final analysis, the U.S. has little technology to gain and much to lose from such a joint venture with Japan.

The U.S. should use the "lessons learned" from our interactions with Japan and employ a "domestic protectionist" policy on technological innovation and technology transfer of sensitive military technology. There is no guarantee that Japan will remain a non-military world power. Historically, economic power is closely associated with military power. The U.S. is putting increasing pressure on Japan to shoulder more of the economic burden of defense of the non-communist world. There is also considerable nationalism in Japan itself. It is very likely that the external and internal pressures will lead to increasing militarization of Japan. Asia in general is forecasted to gain considerable power in comming years. The 21st century is being referred to as the "Pacific Century" by the major media. Cooperation between China, Japan and South Korea could easily lead to a military alliance as powerful as NATO, and not necessarily friendly to the West. It is complacent to assume that this

could not happen. By giving away militarily applicable technology, this process will only be hastened.

In conclusion, the U.S. must take immediate steps to strengthen the defense industrial and technology base, promote rapid technology transition by increased emphasis on process technology, and develop a coordinated government-industry response to counteract Japan's technological competitiveness. Such a response should be predicated on the premise that Japanese national interests, technological strategy, and international industrial goals are not necessarily in harmony with the national security interests of the U.S.

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